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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of)	
)	GEN Docket No. 90-314
Amendment of the Commission's)	ET Docket No. <u>92-100</u>
Rules to Establish New Personal)	
Communications Services)	

COMMENTS OF INTERDIGITAL COMMUNICATIONS CORP.

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Dated: November 9, 1992

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SUMMARY

As a long-time, ardent supporter of introducing personal communications services in the United States in the most rational, spectrum-efficient manner possible, InterDigital proposes certain modifications to the Commission's PCS frequency allocation and licensing scheme proposed in the Notice. In particular, it is critical to the success of PCS that the Commission allocate sufficient spectrum to PCS to ensure that the most efficient and effective PCS technology can be employed. Based on our experimental technology development as well as field test measurements, we believe that 40 MHz (20 MHz for transmission and 20 MHz for reception) should be allocated to each PCS licensee authorized to operate in the 2 GHz band. Similarly, the unlicensed PCS band should be expanded from 20 MHz to 40 MHz to address the demand and service quality needs of the unlicensed PCS marketplace.

Furthermore, InterDigital believes that a rational PCS scheme most likely to engender successful PCS service requires that the Commission not exclude any class of entity from PCS license eligibility. Cellular carriers have wireless expertise that will be vital to the successful launch of the PCS services and local exchange carriers provide needed expertise in integrating radio into the wired infrastructure.

Additionally, InterDigital herein outlines an "open-entry partnership" form of licensing which satisfies the Commission's public interest goals for PCS, consolidates financing, and permits

pioneer preference winners to be guaranteed an operating service area through a guaranteed franchise from one of the partnerships.

Finally, swift action by the Commission on all aspects of PCS is needed to bring the advantages of wireless to the U.S. consumer.

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COMMENTS OF INTERDIGITAL COMMUNICATIONS CORP.

I. INTRODUCTION AND BACKGROUND

InterDigital Communications Corporation ("InterDigital")^{1/} respectfully submits these comments in the above-captioned proceeding. InterDigital is a wireless technology manufacturer that has developed an advanced, spectrum-efficient digital radio system that currently is used to provide wireless loops between telephone central offices and customer premises. The system, called the Ultraphone, is based on a Time Division Multiple Access ("TDMA") technique which allows multiple users to simultaneously share a single radio channel. This technology approach also has been selected by the cellular industry for deployment as the next generation of cellular radio.

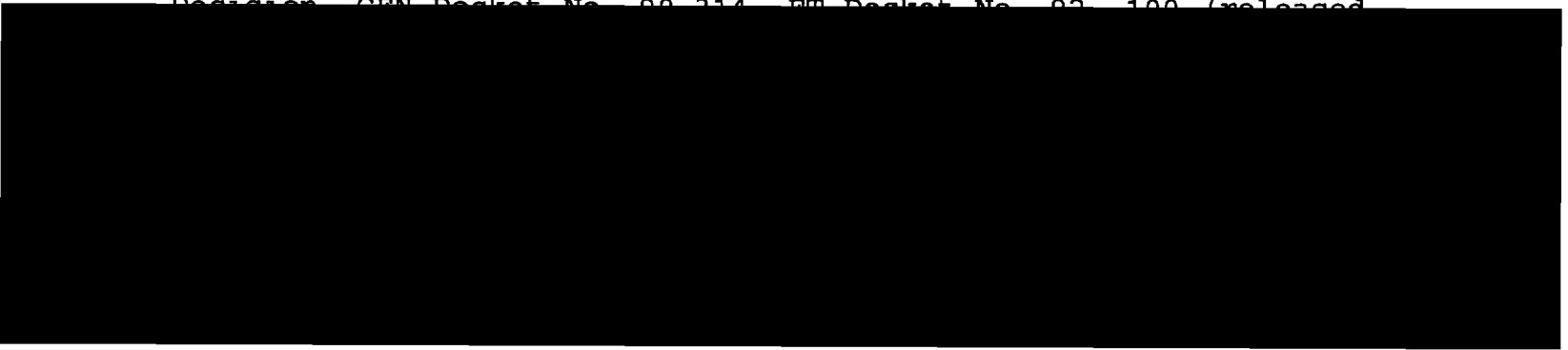
In addition to TDMA technology, InterDigital is a leader in the development of B-CDMA technology. Through its recent

^{1/} On October 15, 1992, International Mobile Machines Corp. ("IMM") acquired SCS Mobilecom/Telecom, Inc., a world leader in Code Division Multiple Access ("CDMA") technology. SCS was one of the early pioneers in testing and proving the merit of Broadband CDMA ("B-CDMA") technology in the PCS microcell environment. The merger of the two companies and their technology staffs has resulted in the formation of InterDigital Communications Corporation.

acquisition of SCS Mobilecom, InterDigital has merged the pioneering CDMA technology accomplishments of SCS with the mature TDMA technology of IMM to form a broadbased wireless technology company uniquely well-positioned to provide a wide array of technology solutions for the wireless industry.

In this proceeding, the FCC brings the promise of personal communications one step closer to realization. In the Notice,^{2/} the Commission sets forth a comprehensive licensing and regulatory proposal for PCS, including various options for introducing PCS rapidly to the marketplace. The specific licensing and operational rules adopted in this proceeding will define the essential features of PCS in the United States for years to come. In many respects, the Commission's action in this proceeding will determine whether American consumers will enjoy the full benefits of the broad range of services included in the "family" of PCS. The rules will also determine whether prospective U.S. PCS providers and PCS equipment manufacturers will be able to participate and develop successfully the PCS market in the near future. With that in mind, InterDigital herein recommends certain modifications to the proposed rules that will provide American consumers and the American PCS industry with a meaningful opportunity to realize the full potential of these innovative new wireless services.

^{2/} Amendment of the Commission's Rules to Establish New Personal Communication Services, Notice of Proposed Rulemaking and Tentative Decision, GEN. Docket No. 92-214, ET Docket No. 92-100 (released



In the Notice, The Commission's spectrum allocation proposals contain alternative models as does its proposal for the size of PCS service areas. The eligibility issue also is posed in terms of various alternatives. The Commission's proposal for unlicensed PCS, including spectrum location and channelization, appears more settled. For purposes of these comments, InterDigital will address generally the broad range of the issues raised by the Commission and offers specific recommendations limited to the areas identified above.

II. DISCUSSION

A. THE PROPOSED ALLOCATION OF 30 MHZ FOR LICENSED PCS PROVIDERS SHOULD BE INCREASED TO 40 MHZ TO PERMIT IMPLEMENTATION OF STATE-OF-THE ART-PCS TECHNOLOGIES

A key concern of the FCC should be to allocate sufficient bandwidth to PCS initially in order to permit state-of-the-art technology to be employed immediately and effectively across the broad range of PCS services. The Commission has chosen to rely on industry and the marketplace to determine what access technologies are best utilized in PCS. To ensure that the market has a meaningful choice, however, adequate spectrum must be made available. Consensus is developing in the engineering community that B-CDMA technology has significant advantages over narrowband techniques in the tightly-spaced microcellular environment of PCS. To capitalize on B-CDMA's advantages, there must be sufficient spectrum available to deliver the voice quality and high-data rate which will be required in the PCS market.

In a CDMA system, bandwidth is a critical factor. As explained in more detail below, it affects, inter alia, capacity, fade margin, data rate, voice quality and performance in both outdoor and indoor environments.

1. Capacity

The capacity of a CDMA system is directly proportional to the ratio of the bandwidth and the coded data rate. Thus capacity increases as bandwidth increases.

2. Fade Margin

The received signal generally consists of delayed versions of the transmitted signal. These are the multipath signals. Those delayed versions of the digital signal that arrive within a chip duration and subtract, cause the received signal to "fade". Those multipath signals arriving outside the chip duration result in an increase in the interference level, but because these components look like additional CDMA signals, they do not produce fading.

The fade margin is inversely proportional to the bandwidth, i.e., the wider the bandwidth, the smaller the chip duration and the fewer the multipath components that fall within a chip duration. Hence, the probability of fading increases as the bandwidth decreases. Appendix A contains experimental data on fade probability and fade margin as a function of bandwidth. These

experiments were performed in an office, as well as outdoor in the suburbs and in downtown New York City.

3. Data Rate

The wider the bandwidth, the higher the data rate for the same processing gain. As the need for ISDN compatibility and multimedia transmission increases, so does the need for a wider bandwidth. For this reason, the narrowband CDMA ("N-CDMA") system being evaluated by the cellular industry is limited to data rates at or below 9.6 kb/s.

4. Voice Quality.

Narrowband CDMA systems require the use of synthetic voice coders in order to achieve the low data rate which is required to obtain a reasonable channel capacity. While significant strides have been made in improving the quality of voice coders, they suffer some serious defects:

- Processing Delay - low bit-rate voice coders can produce processing delays of 80 ms to 160 ms.
- Effect of Background Noise - synthetic voice coders model the human voice producing structure. Hence, communications in a strong background noise environment will result in lower quality voice.

While processing delays and lower voice quality may be acceptable in a mobile environment such as cellular, it is unacceptable in the various applications envisioned for PCS.

Wideband CDMA allows the use of higher data rates. This means that a high quality voice coder operating at 32 kb/s can be used. Moreover, a 32 kb/s voice coder is less costly and draws significantly less battery power than the low bit rate voice coders used in narrowband systems. A cursory review of the hundreds of PCS experimental license reports filed at the FCC reveals that the vast majority of experiments are using 32 kb/s voice coders.

5. Performance (Indoors and Outdoors)

For indoor or for outdoor environments, such as a dense central city areas, beyond line-of-sight communications is the normal mode of transmission. The majority of the multipaths received at a receiver will be delayed from one another by less than one microsecond. Thus, a broadband CDMA system with the wider bandwidth will suffer less fading than a narrower band CDMA system (see Appendix A).

To counteract this degradation in narrowband CDMA performance, it has been suggested by one narrowband CDMA developer that the base station should transmit two delayed versions of the signal (a delay exceeding the chip duration). Such an approach, however, reduces the system capacity by 3 dB. In addition, this is a costly solution. The two-signal transmission "solution" is therefore not a practical remedy for the degradation of narrowband CDMA performance. The correct solution is to use a wider bandwidth CDMA system.

For the above reasons, the Commission should allocate sufficient spectrum to PCS licensees to enable the best technology to be selected for the various PCS applications. PCS is in its infancy. Through PCS it is within our reach to transform the way we communicate in the future. To effect this transformation, however, PCS must deliver communications voice quality as near to wireline quality as possible. The public interest requires that a high quality PCS should not be sacrificed for a few MHz of spectrum. An insufficient spectrum allocation will force costly technology trade-offs, which in turn will drive up the end-user cost of PCS.

**B. DYNAMIC CHANNEL ALLOCATION AND SPREAD SPECTRUM TECHNOLOGY
ENABLES PCS AND MICROWAVE USERS TO SHARE THE BAND**

The microwave users have long considered the frequency spectrum to be their home. InterDigital has shown that B-CDMA technology can share the spectrum with the existing microwave users and that by using Dynamic Capacity Allocation ("DCA"), the PCS system capacity can be automatically regulated to ensure non-interference, even as defined by EIA Document 10E (see Appendix B). It is true that such sharing will limit the number of PCS users per square mile. However, this user density still greatly exceeds that of the current cellular systems. As microwave users leave the band, the number of PCS users can be increased, thereby providing a smooth transition to PCS.

It is also shown in Appendix B that if the microwave equipment currently used by the microwave users is changed to employ spread spectrum technology, it may not be necessary to transition the microwave users to another band in order to introduce PCS. At this early stage of PCS implementation, the Commission should carefully and seriously consider the public interest implications of employing DCA techniques and spread spectrum technologies to address the competing needs for scarce spectrum.

C. THE CHANNELIZATION OF THE UNLICENSED BAND PROPOSED BY THE FCC DISCOURAGES TECHNICAL INNOVATION AND THE ALLOCATION IS INSUFFICIENT TO SUPPORT THE PROJECTED DEMAND

The Commission's proposed channelization plan for the unlicensed band at 1910-1930 MHz imposes needless constraints on technology developers. The Notice proposes that the 20 MHz designated for unlicensed operations be subdivided into three blocks: one block of 10 MHz for broadband technologies, a 5 MHz block divided into four 1.25 MHz blocks and a five 5 MHz block divided into one hundred, 100 KHz blocks.^{3/} An alternate proposal is to overlay two 10 MHz blocks with sixteen 1.25 MHz blocks, which are further overlaid with two hundred 100 KHz channels.

The proposed channelization is driven by the tentative conclusion of the FCC that "there is a need to accommodate three

^{3/} Notice at para. 44.

broad types of PCS technologies."^{4/} This is reflected in the selection of 100 KHz, 1.25 MHz and 10 MHz channels.

This channelization formula appears to coincide with existing voice proposals for narrowband FDMA/TDMA, narrowband CDMA (in the cellular band) and high-speed data proposals for wideband channels. In effect, the proposed channelization sub-assigns narrowband voice services to the narrowband 10 MHz channel while the high-speed data services locate in the wideband 10 MHz channel.

There are several different services and different technologies being contemplated for the unlicensed band which may require a different channelization scheme. Multimedia data transmission is an example of a service requiring a wide bandwidth. CDMA is an example of a technology which yields improved efficiency as the bandwidth is increased. Clearly, locking-in the Commission's channelization rules to existing proposals needlessly hampers technology development for the range of services which may be offered by equipment vendors in this unlicensed band.

Accordingly, InterDigital recommends that the Commission take the same approach in the unlicensed band that the Commission proposes for the licensed blocks of spectrum, i.e., technical flexibility. For licensed blocks of PCS spectrum the Commission proposes to allow ". . . flexibility to channelize the frequency blocks to accommodate the technologies and services that they [the

^{4/} Id.

licensees] wish to provide".^{5/} Similar flexibility would be desirable for equipment manufacturers in the unlicensed band.

Such flexibility will allow not only existing technology approaches to be accommodated but also would accommodate new advanced technology approaches such as the B-CDMA technology described above.

These advanced technologies will be needed to ensure the superior service quality and address the projected demand for unlicensed services. The proposed allocation of 20 MHz is simply not large enough to ensure the high level of service quality or to accommodate the demand for wireless office systems. Accordingly, the allocation should be increased to 40 MHz.

Numerous studies over the last three years have underscored the demand for wireless office systems. Alexander Resources, an Arizona-based management consulting firm conducted a survey to examine wireless in-building markets. The firm surveyed 300 businesses and concluded that 30% of businesses will have wireless telephone systems by 1997.^{6/}

Economic and Management Consultants International Inc. ("EMCI"), a management and consulting firm, found similar results in a study of the penetration of wireless office telephony. In offices with over 400 lines they estimated the penetration to be

^{5/} Id. at para. 38.

^{6/} Opportunities in the U.S. Wireless In-Building Business Communications Market, Alexander Resources, Scottsdale, AZ, December, 1990.

over 26%. They also projected the total market demand over a five year period to be 11 million lines^{7/}.

Accordingly, the demand for wireless office telephone systems will require a substantial block of spectrum from the beginning. The spectrum requirement is driven both by marketplace demand and the need to ensure that the quality of the wireless products is adequate to gain marketplace acceptance.

Moreover, there are service quality and interoperability obstacles facing the PCS equipment suppliers in the unlicensed band. This point was aptly made by Phillips Business Information, Inc.: "[p]roviders of wireless offices will have to jump hurdles including quality of sound and interoperability of the phone system. No one is going to support a telecommunications system that drops calls or cannot complete a transmission." Phillips has also observed that manufacturers must implement the most spectrum efficient technology otherwise ". . .the possibility of wireless applications will become historic before it has had an opportunity".^{8/}

To be successful, PCS equipment developers for the unlicensed band must have sufficient spectrum to allow them to optimize spectrum efficiency and quality. The proposed allocation for

^{7/} U.S. Office Telephony Systems 1991, Economic and Management Consultants, Inc., Washington, DC, June, 1991 AT 14

^{8/} In Building Wireless Communications: The Stepping Stone to PCS, Phillips Business Information, Inc. (1992) at 9, 10 (emphasis added).

unlicensed PCS is inadequate for these purposes and should therefore be increased to 40 MHz.

D. CELLULAR ENTITIES SHOULD BE ELIGIBLE TO BECOME PCS LICENSEES

The Commission's proposal to restrict the eligibility of cellular carriers to acquire 2 GHz PCS licenses and to restrict the LECs' eligibility because of cellular ownership is shortsighted. The rationales for restricting the cellular carriers are that, ". . . competitive benefits may be reduced if cellular incumbents are permitted to acquire PCS licenses within their service areas" and "incumbent cellular operators might limit entry for some period of time by acquiring licenses from potential competitors."^{2/}

These arguments assume that one or both of the cellular licensees will have the ability to stifle competition in their own markets, and further, that cellular carriers have the ability to provide PCS in their own band.

Cellular carriers have obligations that will require careful attention to their own market and diminish their ability to provide competitive services to PCS from within their own spectrum allocation. First, they have an obligation to serve analog customers while simultaneously transitioning to digital technology in those markets needing capacity relief. The transition from analog to digital is proving to be a difficult task. The selection of a digital technology standard has already become bogged down in

^{2/} Id. at para. 64.

the industry evaluation of competing standards. In fact, it appears that in some large markets there could be incompatible digital cellular systems operating.

Cellular providers are currently investigating alternative digital technologies to provide capacity relief in selected markets. To that end, the industry has already selected TDMA (IS-54) as the digital cellular standard. However, narrowband CDMA is also currently being evaluated. Both have their industry proponents. As discussed earlier, CDMA systems operate best in wider bands. InterDigital believes that N-CDMA is a sub-optimal implementation of a CDMA technology which may deliver some capacity relief albeit at the expense of performance, voice quality, lower data rates, and increased cost.

As a result of the lagging transition to digital cellular and the increasing analog subscriber base, the cellular industry is unable to clear sufficient spectrum to allow it to provide a competitive PCS service in its own spectrum. In fact, the cellular industry is currently investigating using B-CDMA as an overlay to their existing systems in order to provide some additional capacity and enable them to provide new services which they have been unable to implement.

B-CDMA can be overlaid on an AMPS, NAMPS or TDMA system and, unlike N-CDMA, does not require that a block of spectrum (and users) be removed in order that the B-CDMA system be installed. Removing the block of spectrum to accommodate N-CDMA would leave the remaining analog AMPS customers with a higher probability of

blocking and poorer service. Also, because the cellular service areas which will receive the initial digital cellular equipment are already near capacity, the call blocking for the existing analog customers will go from bad to worse. Narrowband CDMA clearly is a stop-gap solution for a long range problem.

In contrast, B-CDMA is a long range solution that brings the full capabilities of CDMA to the wireless environment. That is why the Commission should allocate sufficient spectrum for PCS to capitalize on these capabilities and why the cellular industry is interested in the B-CDMA overlay solution.

A B-CDMA overlay will allow cellular licensees to offer some services that they cannot now offer, nor, using AMPS or TDMA, will they be able to offer in the future, such as high-speed data, high quality voice and indoor service.

In-building services are better served by broadband CDMA technology. As noted earlier, the high multipath environment found in offices will mitigate against an in-building narrowband CDMA system.

All of these analog/digital transition issues plus the capacity drain represented by continuing to provide quality service to analog customers places the cellular industry in a very difficult position. Cellular providers hardly seem the robust entities that could exert market power to stifle competition in the PCS market.

The current state of the cellular market is a product of a combination of bad technology choices in the past and insufficient

spectrum today to remedy those mistakes. While B-CDMA can provide some relief in the cellular band, the Commission should guard against allocating insufficient spectrum to PCS at the outset or else the PCS market will be forced to struggle with the same dilemmas now plaguing the cellular market. Indeed, Appendix C, attached, compares the capacity of cellular and PCS systems as a function of data rate and demonstrates that if PCS providers provide a broader bandwidth significant gains in capacity will be achieved. This differential is further increased since the cellular provider must continue to service the analog user.

Allowing cellular carriers to be one of the PCS licensees at 2 GHz seems fair and equitable. There will be other competitors in the same marketplace such as Enhanced SMR ("E-SMR"), 900 MHz PCS providers, two 800 MHz cellular carriers, three PCS providers and finally the various low earth orbiting ("LEO") and geostationary ("GEO") satellite services that will be in place in a few years. It appears that the marketplace is overflowing with competition. Excluding an entire industry sector comprised of companies with the leading wireless expertise is therefore not in the public interest.

E. THE LOCAL EXCHANGE CARRIERS SHOULD NOT BE EXCLUDED FROM THE PROVISION OF PCS

As the Commission recognizes in the Notice, PCS has the potential to be both complimentary to and competitive with basic LEC services. LECs will provide the backbone for many PCS applications and the interconnection of a broad array of wireless

systems into the public switched network. The LECs will also provide advanced intelligent network services to PCS.

In this and other proceedings, PCS has been described in several ways: as a service competitive with cellular radio, as a niche service competing with or enhancing wired pay phones, or, ultimately, as a competitive service for the wired loop. InterDigital believes PCS will be all those things. To exclude the LECs will, however, drastically curtail the full development of PCS and, customers, especially those in suburban and rural areas, will be unlikely to have access to any of these services soon.

For example, one wireless application that has received little attention is the wireless local loop ("WLL") -- and its use in the provision of plain old telephone service ("POTS"). Local exchange carriers have had nearly five years experience in using radio in the local loop under the Basic Exchange Telecommunications Radio Service ("BETRS") rules.^{10/} The majority of BETRS installations are, however, in rural areas. Spectrum shortages have kept BETRS from being offered in urban areas.

The advantages of radio in the loop are well known: reduction in the cost of loop provisioning and rehabilitation, potential for quick installation, availability of temporary and emergency services, and cost effective deployment of redundant capabilities (911 and dual wire center homing).

^{10/} See 47 C.F.R. Section 22.600.

As radio has proven itself more cost-effective than copper in the rural BETRS environment, it will one day prove itself more cost effective than copper in the urban loop environment. If however, the LEC is denied access to this technology that will raise costs to all telephone subscribers by raising the average cost of the local loop.

LECs can provide needed expertise to the PCS industry as it struggles to integrate radio into the wired public network. Provided that proper regulatory and licensing requirements are in place, LECs should be encouraged to participate in PCS.

F. THE COMMISSION SHOULD ADOPT AN OPEN ENTRY LICENSING MECHANISM TO PERMIT ALL QUALIFIED APPLICANTS AN OPPORTUNITY TO PARTICIPATE IN PCS

The Commission reluctantly concluded in the Notice that, absent Congressional authorization for competitive bidding, lotteries are the only viable licensing mechanism.^{11/} The problems with lotteries are well known and need not be repeated here. The recent history of cellular RSA lottery abuse is enough to cause everyone to agree "there's got to be a better way". However, authority for competitive bidding is a remote possibility and the streamlining of the lottery process deals mainly with administrative not substantive factors.

The problem with all licensing schemes is that the objective is to eliminate all prospective licensees but one. A single-winner

^{11/} Supra footnote 2 at para. 82.

mechanism drains capital away from the ultimate licensee and ensures that the final delivery of the service will cost more (to the consumer) than would be the case if the licensing process was not employed.

All current or prospective licensing schemes divert capital away from the efficient and economical delivery of service to the public at the lowest possible cost. The competitive bidding process flows capital into the federal government coffers. The comparative hearing process diverts money to pay expensive legal fees, and the lottery process does both through opening the process to many more applicants and exposure of the process to abuse and litigation. As evidence, some RSA markets still lay fallow after nine years of cellular licensing.

One way to eliminate the delay and the financially exhausting single-winner process is to design a licensing process that is all-inclusive. In that way all capital is focused on the objective of providing service to the public and that service reaches the public early by eliminating the licensing delay, and economically by ensuring the capital is available up front.

One such mechanism, which is described in detail in Appendix D, attached, would be to establish three separate consortiums or partnerships to operate the three PCS licenses on a nationwide basis.^{12/} The consortium could be established based on a

^{12/} Under this model, the larger the market size the more manageable it is to set up the three partnerships. For the sake of balance, we will use three nationwide partnerships in this example.

partnership model with general and limited partners. The general partners would be accepted into the consortium based on a fee paid not to the government but directly into the partnership. Likewise the limited partner would pay in a lesser amount, again directly into the partnership. Limited partners would be granted preemptive rights to become franchisees in markets not served by the partnership.

This approach addresses the Commission's policy favoring multiple licensees in the PCS market while targeting critical capital directly at the rapid introduction of PCS. InterDigital urges the Commission to consider this approach to PCS licensing to promote rapid and efficient introduction of PCS in the United States.


III. THE COMMISSION SHOULD EXPEDITE ITS PCS RULEMAKING PROCEEDINGS

The Commission should move quickly to allocate spectrum to PCS and to adopt a licensing scheme to permit early delivery of PCS services to U.S. consumers. The early conclusion of the regulatory process will allow U.S. manufacturers to capitalize on a "home market" to build a base from which to compete in the international market. Accordingly, U.S. leadership in the international wireless telecommunications marketplace is at stake in this proceeding and needless delay could jeopardize that position.

CONCLUSION

For the reasons discussed above, InterDigital urges the Commission to allocate an additional 20 MHz of spectrum -- 40 MHz in all -- to each 2 GHz PCS licensee in order implement a high quality, efficient PCS service. The unlicensed allocation should also be expanded to 40 MHz to enable unlicensed providers to meet demand for high service quality. Prospective providers in the cellular and local exchange industries can make valuable contributions to successfully implementing PCS and therefore the Commission should not bar any class of entity from participating in the PCS market. The Commission's licensing rules should also incorporate an "open entry partnership" scheme to encourage participation by multiple providers and efficiently target funds to PCS implementation. These recommendations, if adopted, will significantly further the public interest in implementing PCS in the United States as rapidly and efficiently as possible.

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Dated: November 9, 1992

APPENDIX A